

at two sides of the mountain, that merely proves that the light was too feeble to penetrate a distance of 2.45 km., though it was visible at 1.56 km. The reflection of the moonlight was also stronger at point 0 than at III., because on this occasion the moon was nearly north-east.

It is not easy, I confess, to make a *résumé* of the results arrived at by the researches of the Finnish Expedition to Lapland concerning the electric currents of the earth and the atmosphere, chiefly owing to the circumstance that the materials are not as yet fully analysed, but the following may, however, be accepted as quite certain, as they are based on actual observations:—

The aurora borealis, which has long been a disputed enigma, is the result of an atmospheric electric current.

This auroral current can be measured, and, as a rule, studied, by the methods employed by the Expedition.

The "discharging-apparatus," or network of pointed conductors, used by the Expedition, has very often produced a diffuse light which gave in the spectroscope an auroral spectrum. Under very favourable conditions the light appeared in the form of rays above the apparatus.

With a Holtz electric machine the diffuse light may be produced under favourable conditions, and if it exists already it may be considerably intensified by the same means.

For the study of terrestrial electric currents a method has been found which, while avoiding all foreign influences, permits of the current being measured, both as regards absolute strength and as regards the exact laws which regulate it.

From these experiments it seems that the existence of a belt of terrestrial currents similar to the belt of auroral currents is very probable.

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## ON THE NATURE OF LICHENS

IN the *Journal* of the Linnean Society for December 12, 1884 (Botany) there appears a review of the "Algo-Lichen Hypothesis," by the Rev. J. M. Crombie, F.L.S., from the strongly conservative point of view of Nylander, on which I desire to make a few remarks as a critical student of Botany at large.

Mr. Crombie cites, as a fatal objection to Schwendener's hypothesis of symbiosis between the lichen proper and the alga forming its gonidia, that in other cases of vegetable parasitism "the hosts usually become speedily exhausted and finally perish, often involving in their death that of the parasite itself;" whereas here we have "a parasite exceeding in size and number of cells by many hundred times the nourishing plant which it invests." It is now over six years since I sent you, with reference to this very point, a brief note on the subject, which probably escaped Mr. Crombie's notice by its brevity, and of which I reproduce the substance. The essential elements of nutrition of a fungus, so far as we can judge from culture experiments, are as follows:—(1) *ash constituents*; (2) *nitrogen* in the form of nitrates, nitrites, or ammonia; (3) *carbon and hydrogen combined* in the form of tartrate, carbohydrate, or fat, &c. An alga requires only Nos. 1 and 2, deriving No. 3 by assimilation from the carbon dioxide of the atmosphere and water. The lichen hyphæ, aided by excretion of carbon dioxide, can dissolve the ash constituents, No. 1, from the substratum, taking them up by the rhizoids; the rain probably brings No. 2 in the form of traces of nitrates; No. 3 can only be formed by assimilation in the algal part or gonidia of the lichen. But, to obtain the carbohydrates, No. 3, there is no need for the hypha to penetrate the gonidium or to molest its protoplasm, as the algal cells have a cellulose wall, of which the outer layers undergo constant gelification and renewal. Into this it is that, as shown by Bornet ("Sur les Gonidies des Lichens," *Ann. Sc. Nat. Bot.*, ser. 5, xvii.) the hyphæ penetrate; and if they only lived on this, once formed, there would be no strain whatever on the resources of the alga. But, even if they stimulate an abnormally rapid cellulose formation, the injury need not necessarily be severe. We see oysters living well, though their shells are burrowed by the sponge *Cliona*; they produce new layers of shells far faster than when they are sound, but are otherwise uninjured.

An unlooked-for confirmation of these views is found in Johow's account of the Hymenolichenes (in Pringsheim's *Fahrbücher*, xv., part 2), where, "in consequence of the unusually close and perfect investment of the gonidia" by the hyphæ, the

gelatinous investment of their cell-wall completely disappears. This is in marked contrast with the usual state of things as figured by Bornet.

De Bary puts the case thus:—"With their growth (of the alga) the assimilation of carbon dioxide persists in their protoplasm with its chlorophyll, and produces organic carbon compounds utilisable by the fungus. At the same time the rhizoids of the fungus ramify on and in the substratum, and bring the mineral pabulum required. These two processes support and complement one another (*Vergleichende Morphologie u. Physiologie d. Pilze*, &c., 1884, p. 425).

It is further noteworthy that, if the growth in size of the gonidia is often favoured by their inclosure in the lichen-thallus, their rapidity of multiplication by division is notably impeded; while spore-formation, &c., remains in complete abeyance.

Mr. Crombie recalls the absence of alga in places where lichens abound, e.g. "granitic detritus and boulders towards the summit of lofty mountains." This follows from the fact that the alga alone cannot there obtain, unassisted, their papulum No. 1, the mineral substances or ash constituents. The absence of the fungi *alone* from these localities simply shows that they cannot live without their algal gonidia.

Mr. Crombie gives as an essential distinction between the hyphæ of lichens and those of fungi the character of their cell-wall: "perennial, firm, penetrated by lichenin, thick, imputrile, and insoluble in caustic potash in the former; caducous, very soft, with thin walls, readily putrifying on maceration, and, on the application of caustic potash, immediately becoming dissolved."

As regards the thickness and permanence of the walls, it needs hardly be recalled how much this character varies in different parts of the same fungus, and notably in corresponding organs of different members of the same group of fungi: compare *Polyporus* and *Boletus*, *Schizophyllum* and *Coprinus*. As to the presence of lichenin, De Bary states (*op. cit.*, p. 10) that in at least three gelatinous fungi—*Hydium erinaceus*, *Polystigma*, and *Hysterium macrosporium*—the hypha turns blue on the application of aqueous solution of iodine, that is, gives the "lichenin reaction."

As regards the alleged solubility of fungus hyphæ in caustic potash, I am at a loss to understand it, having, like most workers, been in the habit of using this reaction "for clearing" vegetable preparations to demonstrate the presence of parasitic fungus hyphæ, which would be impossible if it dissolved them. And I find no account of this solubility of fungal cell-walls in Hofmeister's very complete "*Lehre von der Pflanzenzelle*," or in De Bary's above-cited work.

A misapprehension on the part of the author is to think that the Schwendenerian school have overlooked the "cellular cortical layer" when they speak "as if only two elements entered into the structure of lichens, viz. hyphæ and gonidia." This is due, so far as it is true, to the general recognition by mycologists that such pseudo-parenchyma as that composing the cellular cortical layer of lichens, of fungus sclerotia, &c., is only an extreme modification of the hyphæ. But, far from being ignored, it is figured and described by Sachs ("Text-Book of Botany," (1st Engl. ed., Figs. 188, 189, and explanation), who says: "The upper and under cortical layers [of *Stictia*] also consist of hyphæ, which, however, . . . consist of shorter cells, and are united without interstices, forming a pseudo-parenchyma." Its formation is also described by Bornet (*op. cit.*, p. 97), and De Bary writes (*op. cit.*, p. 436): "The hypha-branches forming the cortical layer ('Rindenschicht') are united without interstices, save in certain species of *Rocella*. They are either recognisable as such, having the lumina of their segment-cells evidently elongated and cylindrical, even though shorter than those of the medulla, or else they are formed of short isodiametric rounded prismatic cells, giving the cortex the structure of a pseudo-parenchyma, which is often extremely regular and neat ('zierlich'). . . . The structure of these cortical layers shows great similarity to that of many sclerotia."

In the latter half of the paper Mr. Crombie exposes at length the view that the gonidia originate in the cellules of the hypothalline and cortical layers,<sup>1</sup> and illustrates it by figures. In this no attempt is made to show the part played by the protoplasm in the process, an omission which is an implied confession of the inadequacy of the weapons, optical and technical,

<sup>1</sup> As regards his statement that "specimens illustrating the earlier stages of lichen growth appear to be unknown to the supporters of Schwendenerianism," it is only necessary to revert to Bornet's paper, p. 97.

employed in the investigations on which the view is based.<sup>1</sup> Considering that chlorophyll bodies and plastids generally are unknown in hyphæ of all kinds, and in view of the recent researches on the part played by nuclei in cell formation, we had a right to expect some allusion to these matters in a research dated 1884. As regards the optical powers employed, two instances will suffice. Fig. 7 is stated to be highly magnified; 7a, a more highly magnified part thereof, is only enlarged 275 diameters, and this is the highest power used! Fig. 7a is stated to show "the separated gonidia [of *Psoroma hyphorum*] inclosed in the cellulæ [of the cortex], after Nylander." It represents, in fact, a homogeneous green spot separated by a narrow blank space from the concentric double black outline. Fig. 2a, "Gonidia [of *Lecanora gibba*], as seen inclosed in the cellulæ of the pseudo-parenchyma, magnified about 270 diameters," only differs from 7a in the black outline being single instead of double; and these two figures are the only ones professing to illustrate the actual formation of the gonidia!

So much for the formation of the gonidia from the hyphæ or the derived cellular cortical layer. Of the inverse origin of hyphæ from gonidia, the author gives no hint; yet, surely this should be taken into consideration also in a complete account of the lichen as a simple organism? Mr. Crombie states that "*Sirospion*, *Hormosiphon*, *Scytonema*, *Stigonema*, *Cora*, *Dichonema*, *Chroolepus* or *Trentepohlia*, *Nostoc* and *Glaucocapsa* (at least in part), *Gongrosira* and *Phyllactidium*, have now to be removed from the class of the algae," having, "in consequence of the discovery of their fructification, been proved to be lichens." Such papers as those of Bornet and Johow are in complete discordance with this view, except as regards *Cora* and *Dictyonema* (or *Dichonema*). Mr. Crombie seems to be unaware that the discovery of a *hymenomycetous* fructification in these very genera of lichens by Mattirollo ("*Contribuzione allo Studio del genere Cora*," in *Nuov. Giorn. Bot. Ital.*, vol. xiii. 1881), confirmed and extended by Johow, is regarded by most botanists as the very coping-stone of the symbiosis theory founded by De Bary and Schwendener; but their papers are not referred to.<sup>2</sup>

I may say that I have personally hunted through many a *Nostoc* colony without finding a trace of hyphæ; and there is no record of the transmutation of a *Nostoc*-cell into a lichen or fungus hypha. Yet this is wanting to show that *Nostoc* is the immature form of a lichen. So I have frequently seen *Glaucocapsa* colonies permeated by hyphæ, which could often be traced to septate (probably lichen) spores, but, like all other observers, never to a green cell. *Gongrosira* has been demonstrated by Stahl to be at least in part the resting form of *Vaucheria* ("*Die Ruhezustand der Vaucheria geminata*," in *Bot. Zeit.*, 1879, p. 129, t. ii.), and must henceforward rank only as a form-genus. *Phyllactidium* is another form-genus, comprising young forms of genera so distinct as *Coleochaete* and *Mycoidia*, Cunn.

I have abstained from reviewing the purely critical appreciation of the works of Schwendener, Bornet, Rees, Stahl, &c., though Mr. Crombie's treatment thereof seems to me decidedly offhand. But I trust that in my remarks on his positive arguments in favour of the unitary theory of lichens, I have not exceeded the bounds set by the respect all must feel towards his honest and arduous work on the classification of so difficult a group.

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MARCUS M. HARTOG

### UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—A temporary Pathological Laboratory has been fitted up for Prof. Roy, and it is proposed to vote 400*l.* for apparatus.

Downing College has now a capital opportunity of appointing a scientific man as Master, owing to the death of Dr. Worsley.

Mr. C. Dixon has been appointed a Demonstrator of Mechanism and Applied Mechanics in place of Mr. J. H. Nicholls, resigned.

A discussion took place last Friday on the Report as to a new Chemical Laboratory. Prof. Liveing stated in forcible terms the inadequacy of the present laboratories, which were inferior to those of many schools. He could not classify students; he had no class-rooms, and literally no provision for research.

<sup>1</sup> The wonderful results obtained by Mink and Müller in their researches on the "Microgonidia of Lichens" show that *high powers alone* do not suffice for scientific investigation. Mr. Crombie has rightly rejected their views.

<sup>2</sup> Johow's could hardly have reached England before the composition of Mr. Crombie's paper. Mattirollo's dates from 1881.

Cambridge was subjected to severe competition; a new University in the north of England was supplying considerable means of research; and before long it must be expected that the plans for a Teaching University for London would be carried out. It would be economical to make good provision while they were about it. The estimated sum of 30,000*l.* was as low as would provide suitable accommodation. The chief objections urged against the proposal were as to the magnitude of the sum in proportion to other requirements and to the funds at the disposal of the University. Prof. Humphry made a vigorous appeal to men of wealth, who might find in Cambridge many objects worthy of their munificence. Cambridge laboured under the double disadvantage of being poor and of being thought rich.

THE following courses of Lectures and Demonstrations in special branches of Physics will be given in the Physical Lecture Room and Laboratories of the Science Schools, South Kensington:—(1) Connection between Sound and Music. Six Lectures and Demonstrations by R. Mitchell, at 2 p.m. on February 23, 25, 27, March 2, 4, 6. (2) Certain Optical Measurements. Eight Lectures and Demonstrations by H. H. Hoffert, B.Sc., at 2 p.m. on March 9, 11, 13, 16, 18, 20, 23, 25. (3) Electrical Measurements. By C. V. Boys, A.R.S.M., at 2 p.m. on April 13, 15, 17, 20, 22, 24, 27, 29; May 1, 4. (4) The Chemical Action of Light. By Capt. W. de W. Abney, F.R.S., at 2 p.m. on May 6, 8, 11, 13, 15, 18, 20, 22. The above courses are open without fee to all second and third years' regular students of the Normal School of Science and Royal School of Mines, on their giving to the Registrar a written recommendation from the Professor or Lecturer whose classes they are attending at the time. The fee to others attending the courses are: for each separate course, 10*s.*; for all the courses, 30*s.* Such fees are payable in advance to the Registrar of the Normal School of Science and Royal School of Mines. These courses will only be given if a certain number of applications are made a week before February 23. Those intending to join are therefore requested to do so as soon as convenient. All the courses are open to women.

### SOCIETIES AND ACADEMIES LONDON

Royal Society, January 29.—"On the Structure and Development of the Skull in the Mammalia. Part III. Insectivora." By W. K. Parker, F.R.S.

Although this paper is confessedly only a fraction of what is necessary to be done in this polymorphic order, it shows at least how difficult a group it is to handle. For the Insectivora are set in the midst of the other mammalia—low and high. They might be called the biological stepping-stones from the Metatheria to the Eutheria.

One thing can be done, even now, with our present fragmentary knowledge of the structure and development of the insectivorous types—we can assure ourselves that these types are immediately above the Marsupials, that they have the bats (Chiroptera) obliquely above them, that their nearest relations must be sought for amongst extinct Eocene forms, and that, lowly as they are, and arrested and often dwarfed to the uttermost (so that nature could not safely go further in that direction), they are rich in prophetic characters that have come to perfection in larger and nobler types.

I think it will not be denied that in the ascent of the types the Chiroptera are above the Insectivora, and, as it were, a sort of special "new leader" from that stock, and that the Insectivora are more or less transformed modifications of the marsupial type. I suspect that the existing Insectivora just yied the zoologist one of his groups of types classed together because he knows not what else to do with them; they are not a proper, clear, special branch or "leader" of the mammalian life-tree. They form one group under one designation, just as the *poor* of this metropolis form a group; their special mark is simply lowliness; they differ *inter se* almost as much as the whole remainder above them differ. The higher forms, however, because of their elevation, can afford to be sub-divided again into order after order. If we could descend and see the transforming and newly transformed Placentalia of the Eocene epoch, then the morphologist and the zoologist would find common ground; the taxonomy of the latter, however, would be as useless as the titles and distinctions of modern society to some undeveloped race of savage men.

The best type of Insectivore for general comparison is the